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A STUDY OF ENGINEERING CURRICULA.

(Continued.)

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GRADUATION REQUIREMENTS IN MECHANICAL ENGINEERING.

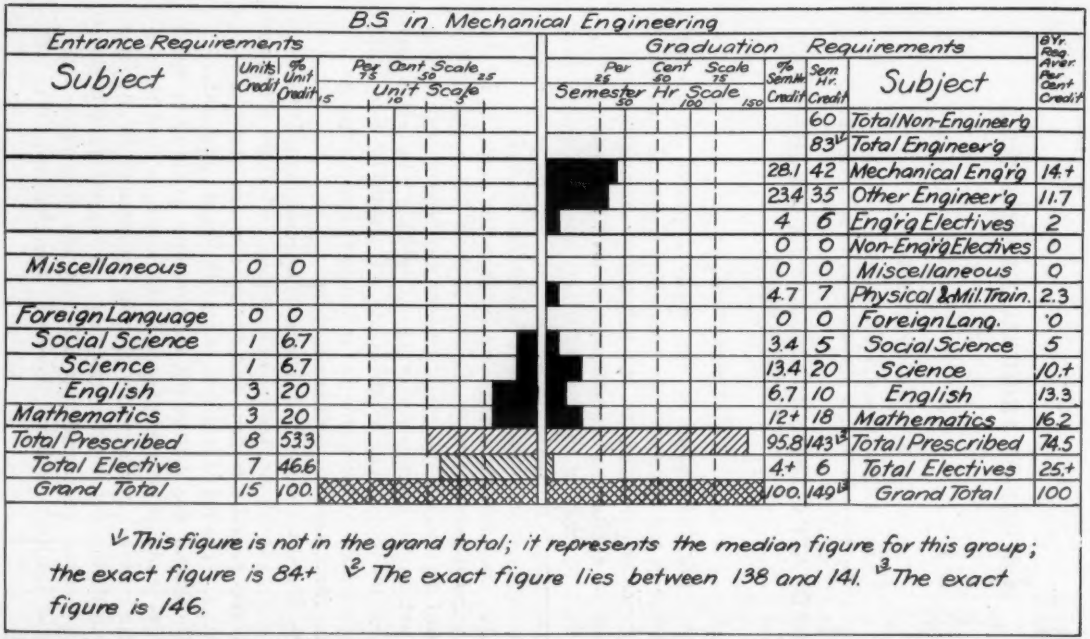
INTRODUCTION.

The first installment of this study appeared in the last number of the JOURNAL. It comprised a general analysis of entrance requirements to the colleges of engineering and a study of graduation requirements in civil engineering. The method of treating the subject which was used in the first installment is continued in the present installment. No further explanation of the method is therefore needed.

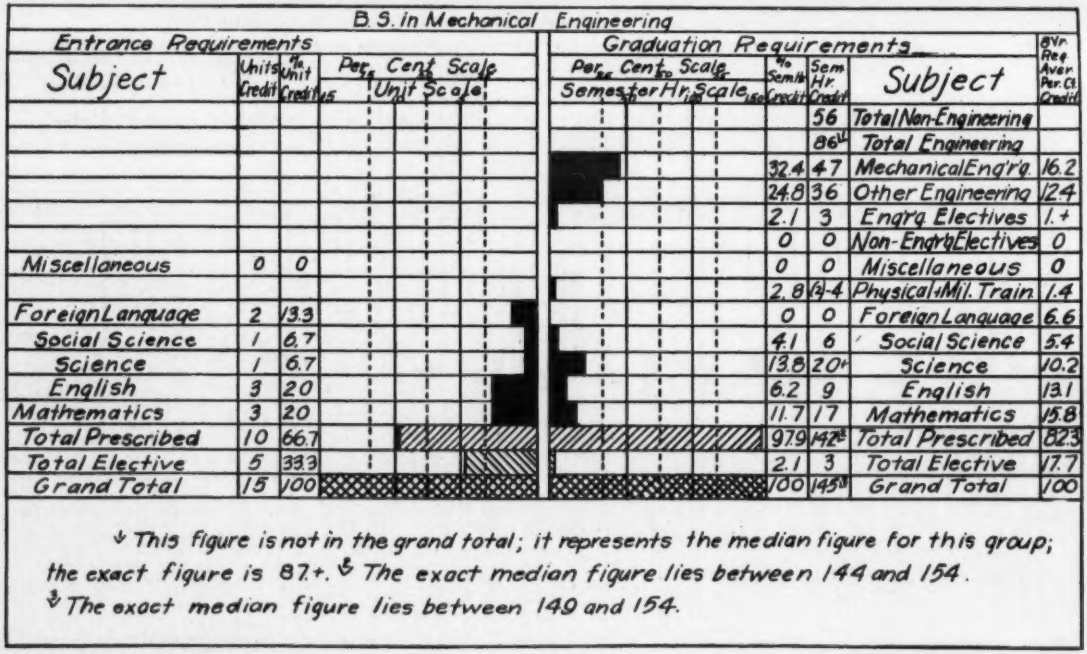
The graphical summaries are likewise the same as in the first installment. Graphs D and E show the requirements both for entrance and graduation in mechanical engineering, as well as the average percentage of credit for the eight-year period for the various requirements. It should be noted that the entrance requirements for mechanical engineering do not differ from those for civil engineering.

Seventy-six colleges and schools of engineering are included in the study of mechanical engineering. Of these fifty-four are under public control and twenty-two are under private control. The list of institutions may be found on pp. 585–587.

In general the institutions are the same as those included in the study of civil engineering. However, several institutions included in the study of civil engineering do not offer curricula in mechanical engineering. A few others offer five-year courses or courses operated on the cooperative plan. These institutions have therefore been omitted from the

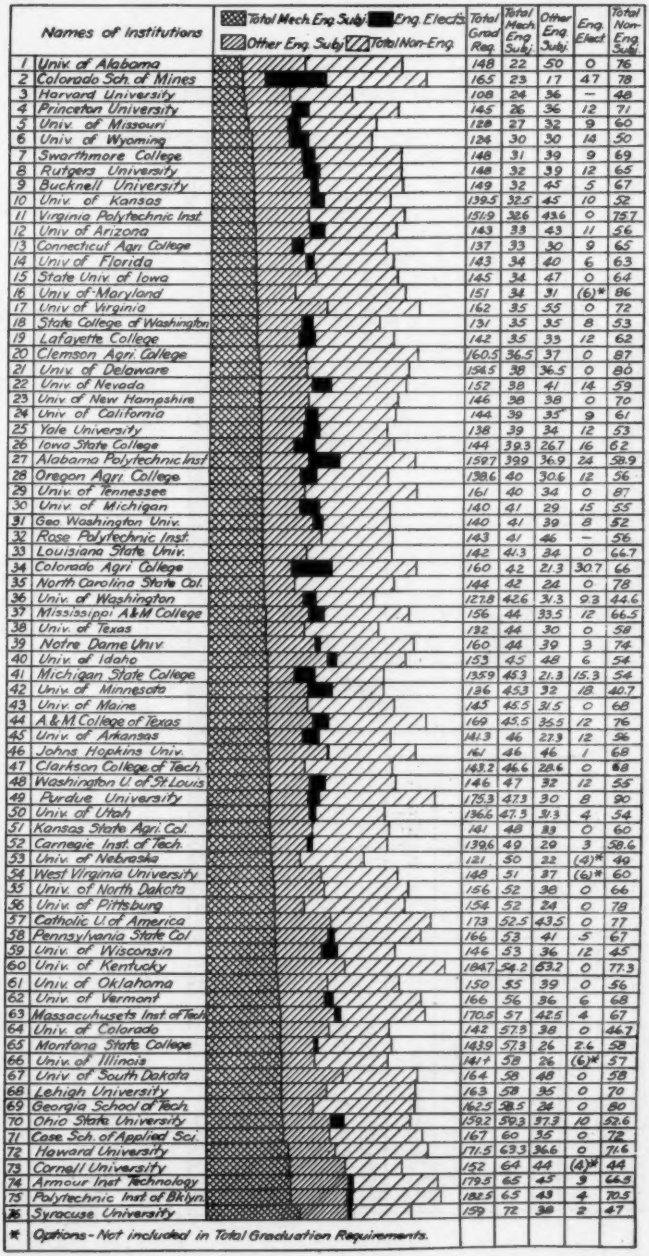

B.S. in Mechanical Engineering
Entrance Requirements
Graduation Requirements
Subject
Units Credit
% Unit Credit
Per Cent Scale 75 50 25
Unit Scale 15 10 5
Per Cent Scale 25 50 75 100 150
Semester Hr Scale
% Semester Credit
Sem. Hr. Credit
Subject
B'Yr. Req. Aver. Per Cent Credit
Miscellaneous 0 0
Foreign Language 0 0
Social Science 1 6.7
Science 1 6.7
English 3 20
Mathematics 3 20
Total Prescribed 8 53.3
Total Elective 7 46.6
Grand Total 15 100.
60 Total Non-Engineer'g
83 1 Total Engineer'g
28.1 42 Mechanical Eng'r'g 14.+
23.4 35 Other Engineer'g 11.7
4 6 Eng'r'g Electives 2
0 0 Non-Eng'r'g Electives 0
0 0 Miscellaneous 0
4.7 7 Physical & Mil. Train. 2.3
0 0 Foreign Lang. 0
3.4 5 Social Science 5
13.4 20 Science 10.+
6.7 10 English 13.3
12+ 18 Mathematics 16.2
95.8 143 2 Total Prescribed 74.5
4.+ 6 Total Electives 25.+
100. 149 3 Grand Total 100
1 This figure is not in the grand total; it represents the median figure for this group; the exact figure is 84.+
2 The exact figure lies between 138 and 141.
3 The exact figure is 146.

GRAPH D. ANALYSIS OF FOUR-YEAR MECHANICAL ENGINEERING CURRICULA BASED ON THE MEDIAN FIGURES OF THE REQUIREMENTS OF 54 PUBLICLY CONTROLLED SCHOOLS OF ENGINEERING. 1924–1925.



↓ This figure is not in the grand total; it represents the median figure for this group; the exact figure is 87.+. ↕ The exact median figure lies between 144 and 154. ↕ The exact median figure lies between 149 and 154.

GRAPH *E*. ANALYSIS OF FOUR-YEAR MECHANICAL ENGINEERING CURRICULA BASED ON THE MEDIAN FIGURES OF THE REQUIREMENTS OF 22 PRIVATELY CONTROLLED SCHOOLS OF ENGINEERING. 1924–1925.



	Names of Institutions	Total Grad Req.	Total Mech. Eng Subj.	Other Eng. Subj.	Eng. Elect.	Total Non-Eng. Subj.
1	Univ. of Alabama	148	22	50	0	76
2	Colorado Sch. of Mines	165	23	17	47	78
3	Harvard University	108	24	36	—	48
4	Princeton University	145	26	36	12	71
5	Univ. of Missouri	128	27	32	9	60
6	Univ. of Wyoming	124	30	30	14	50
7	Swarthmore College	148	31	39	9	69
8	Rutgers University	148	32	39	12	65
9	Bucknell University	149	32	45	5	67
10	Univ. of Kansas	139.5	32.5	45	10	52
11	Virginia Polytechnic Inst	151.9	32.6	43.6	0	75.7
12	Univ. of Arizona	143	33	43	11	56
13	Connecticut Agri. College	137	33	30	9	65
14	Univ. of Florida	143	34	40	6	63
15	State Univ. of Iowa	145	34	47	0	64
16	Univ. of Maryland	151	34	31	(6)*	86
17	Univ. of Virginia	162	35	55	0	72
18	State College of Washington	131	35	35	8	53
19	Lafayette College	142	35	33	12	62
20	Clemson Agri. College	160.5	36.5	37	0	87
21	Univ. of Delaware	154.5	38	36.5	0	80
22	Univ. of Nevada	152	38	41	14	59
23	Univ. of New Hampshire	146	38	38	0	70
24	Univ. of California	144	39	35	9	61
25	Yale University	138	39	34	12	53
26	Iowa State College	144	39.3	26.7	16	62
27	Alabama Polytechnic Inst	159.7	39.9	36.9	24	58.9
28	Oregon Agri. College	138.6	40	30.6	12	56
29	Univ. of Tennessee	161	40	34	0	87
30	Univ. of Michigan	140	41	29	15	55
31	Geo. Washington Univ.	140	41	39	8	52
32	Rose Polytechnic Inst.	143	41	46	—	56
33	Louisiana State Univ.	142	41.3	34	0	66.7
34	Colorado Agri. College	160	42	21.3	30.7	66
35	North Carolina State Col.	144	42	24	0	78
36	Univ. of Washington	127.8	42.6	31.3	9.3	44.6
37	Mississippi A&M College	156	44	33.5	12	66.5
38	Univ. of Texas	132	44	30	0	58
39	Notre Dame Univ.	160	44	39	3	74
40	Univ. of Idaho	153	45	48	6	54
41	Michigan State College	135.9	45.3	21.3	15.3	54
42	Univ. of Minnesota	136	45.3	32	18	40.7
43	Univ. of Maine	145	45.5	31.5	0	68
44	A & M. College of Texas	169	45.5	35.5	12	76
45	Univ. of Arkansas	141.3	46	27.3	12	56
46	Johns Hopkins Univ.	161	46	46	1	68
47	Clarkson College of Tech.	143.2	46.6	28.6	0	68
48	Washington U. of St. Louis	146	47	32	12	55
49	Purdue University	175.3	47.3	30	8	90
50	Univ. of Utah	136.6	47.3	31.3	4	54
51	Kansas State Agri. Col.	141	48	33	0	60
52	Carnegie Inst. of Tech.	139.6	49	29	3	58.6
53	Univ. of Nebraska	121	50	22	(4)*	49
54	West Virginia University	148	51	37	(6)*	60
55	Univ. of North Dakota	156	52	38	0	66
56	Univ. of Pittsburg	154	52	24	0	78
57	Catholic U. of America	173	52.5	43.5	0	77
58	Pennsylvania State Col	166	53	41	5	67
59	Univ. of Wisconsin	146	53	36	12	45
60	Univ. of Kentucky	184.7	54.2	53.2	0	77.3
61	Univ. of Oklahoma	150	55	39	0	56
62	Univ. of Vermont	166	56	36	6	68
63	Massachusetts Inst. of Tech.	170.5	57	42.5	4	67
64	Univ. of Colorado	142	57.3	38	0	46.7
65	Montana State College	143.9	57.3	26	2.6	58
66	Univ. of Illinois	141+	58	26	(6)*	57
67	Univ. of South Dakota	164	58	48	0	58
68	Lehigh University	163	58	35	0	70
69	Georgia School of Tech.	162.5	58.5	24	0	80
70	Ohio State University	139.2	59.3	37.3	10	52.6
71	Case Sch. of Applied Sci.	167	60	35	0	72
72	Howard University	171.5	63.3	34.6	0	71.6
73	Cornell University	152	64	44	(4)*	44
74	Armour Inst. Technology	179.5	65	45	9	66.5
75	Polytechnic Inst. of Bklyn.	182.5	65	43	4	70.5
76	Syracuse University	159	72	38	2	47
*	Options - Not included in Total Graduation Requirements.					

GRAPH *F*. SHOWING RELATIONS OF ENGINEERING SUBJECTS TO EACH OTHER BY GROUPS.

TABLE III.

GRADUATION REQUIREMENTS IN MECHANICAL ENGINEERING IN 54 PUBLIC INSTITUTIONS, 1924–1925.

Names of Institutions.	Total Semester Hours.	Total Prescribed Semester Hours.	Total Elective Semester Hours.	Mathematics.	English.	Physical Science.	Social Science.	Foreign Language.	Physical and Military Training.	Miscellaneous Subjects.	Non-Engineering Electives.	Mechanical Engineering.	Other Engineering.	Engineering Electives.	Total Non-Engineering.	Total Engineering.
1. Alabama Polytechnic Institute	159.7	135.7	24	20	12	15.3	5	0	6.6	0	0	39.9	36.9	24	58.9	100.8
2. University of Alabama	148	134	14	20	4	24	10	0	4	0	14	22	50	0	76	72
3. University of Arizona	143	132	11	17	10	16	0	8	0.5	0	0	33	43	11	56	87
4. University of Arkansas.*	141.3	129.3	12	22	6	18	.6	0	4	0	0	46	27.3	12	56	85.3
5. University of California	144	120	24	16	—	22	0	0	8	0	15	39	35	9	61	83
6. University of Colorado.*	142	142	0	18	8.6	18	0	0	2	0	0	57.3	38	0	46.7	95.3
7. Colorado Agricultural College	160	129.3	30.7	24	6	20	0	0	16	0	0	42	21.3	30.7	66	94
8. Colorado School of Mines	165	118	47	20	6	44	0	0	8	0	0	23	17	47	78	87
9. Connecticut Agricultural College	137	128	9	15	12	16	12	0	10	0	0	33	30	9	65	72
10. University of Delaware	154.5	154.5	0	24	12	19	7	6	12	0	0	38	36.5	0	80	74.5
11. University of Florida	143	137	6	16	6	26	6	0	9	0	0	34	40	6	63	80
12. Georgia School of Technology	162.5	162.5	0	22.3	15	21	3	12	6.6	0	0	58.5	24	0	80	82.5
13. University of Idaho	153	147	6	18	10	18	0	0	8	0	0	45	48	6	54	99
14. University of Illinois	141+	141	(15)	18	6	16+	0	8	6	0	(9)	58	26	(6)	57	84
15. Purdue University	175.3	161.3	14	20	12	14.7	6	(10)*	21.3	0	6	47.3	30	8	90	85.3
16. State University of Iowa	145	145	0	20	12	19	5	0	8	0	0	34	47	0	64	81
17. Iowa State College.*	144	120	24	19.3	8.7	23.3	6.7	0	4	0	0	39.3	26.7	16	62	82
18. University of Kansas	139.5	129.5	10	20	8	21	3	0	0	0	0	32.5	45	10	52	87.5
19. Kansas State Agricultural College	141	141	0	18	10	18	8	0	6	0	0	48	33	0	60	81
20. University of Kentucky	184.7	184.7	0	23	20	26	1	0	7.3	0	0	54.2	53.2	0	77.3	107.4
21. Louisiana State University.*	142	142	0	20.6	12	24	4	0	6	0	0	41.3	34.6	0	66.6	75.3
22. University of Maine	145	145	0	20	12[1]	23	10	0	—	3	0	45.5	31.5	0	68	77
23. University of Maryland	151	151	(6)	20	14	22	8	14*	8	0	0	34	31	(6)	86	65
24. University of Michigan	140	125	15	18	6	15	0	16[2]	0	0	0	41	29	15	55	85
25. Michigan State College.*	136	114.6	21.3	16	8	16	(12)*	(6)*	8	0	6	45.3	21.3	15.3	54	82
26. University of Minnesota.*	136	118	18	16.7	6	18	0	0	—	0	—	45.3	32	18	40.7	95.3
27. Mississippi A. and M. College	156	144	12	15	11	24.5	16	0	—	0	(12)	44	33.5	12	66.5	89.5

[1] Includes public speaking.

[2] Includes cultural electives.

* Figures reduced to semester hours from a term or quarter basis.

TABLE III.—*Continued.*

Names of Institutions.	Total Semester Hours.	Total Prescribed Semester Hours.	Total Elective Semester Hours.	Mathematics.	English.	Physical Science.	Social Science.	Foreign Language.	Physical and Military Training.	Miscellaneous Subjects.	Non-Engineering Electives.	Mechanical Engineering.	Other Engineering.	Engineering Electives.	Total Non-Engineering.	Total Engineering.
28. University of Missouri	128	119	9	20	12	15	5	0	8	0	0	27	32	9	60	68
29. Montana State College.*	144	141.4	2.6	18	10	18	4	0	8	0	0	57.3	26	2.6	58	86
30. University of Nebraska	121	121	(4)	20	4	16	3	0	4	2	0	50	22	(4)	49	72
31. University of Nevada	152	138	14	16	6	22	2	0	10	3	0	38	41	14	59	93
32. University of New Hampshire	146	134	12	18	10	22	0	0	8	0	12	38	38	0	70	76
33. Rutgers University	148	136	12	20	12	14	4	6	9	0	0	32	39	12	65	83
34. Cornell University.†	152	152	(4)	11	4	22	7	0	—	0	0	64	44	(4)	44	108
35. North Carolina State College.*	144	132	12	20	12	18	8	0	8	0	12	42	24	0	78	66
36. University of North Dakota	156	156	0	18	14	22	6	0	6	0	0	52	38	0	66	90
37. Ohio State University.*	159.3	149.3	10	20	6	20	0	0	6.6	0	0	59.3	37.3	10	52.6	106.7
38. University of Oklahoma	150	150	0	19	8	18	7	0	4	0	0	55	39	0	56	94
39. Oregon Agricultural College.*	138.6	126.6	12	18	10	12	6	0	10	0	0	40	30.6	12	56	82.6
40. Pennsylvania State College	161	156	5	16	10	15	9	8	9	0	0	53	41[3]	5	67	94
41. Clemson Agricultural College	160.5	160.5	0	21	16	20	10	0	20	0	0	36.5	37	0	87	73.5
42. University of South Dakota	164	164	0	15	3	25	3	0	12	0	0	58	48	0	58	106
43. University of Tennessee	161	155	6	18	12	22	6	0	20	3	6	40	34	0	87	74
44. University of Texas.*	132	132	0	16	12	24	6	0	0	0	0	44	30	0	58	74
45. A. and M. College of Texas	169	157	12	22	16	24	6	0	8	0	0	45.5	35.5	12	76	93
46. University of Utah.*	136.6	130.6	6	20	6	22	2	0	2	0	2	47.3	31.3	4	54	82.6
47. University of Vermont	160	154	6	24	8	20	4	0	12	0	0	56	36	6	58	98
48. University of Virginia	162	162	0	18	12	24	18	[4]	0	0	0	35	55	0	72	90
49. Virginia Polytechnic Institute.*	152	152	0	20	12	18	4	0	21.3	0.4	0	32.6	43.6	0	75.7	76.3
50. University of Washington.*	128	119	9	14	2	20	2	0	6.6	0	0	42.6	31.3	9.3	44.6	83.4
51. State College of Washington	131	121	10	16	8	14	6	0	7	0	2	35	35	8	53	78
52. West Virginia University	148	148	(6)	16	7	23	10	0	4	0	0	51	37	(6)	60	88
53. University of Wisconsin	146	131	15	18	6	18	0	0	—	0	3	53	36	12	45	101
54. University of Wyoming.*	124	110	14	18	6	18	0	0	8	0	0	30	30	14	58	74

[3] Approximate.

[4] Six hours of foreign language may be substituted for social science.

* Figures reduced to semester hours from a term or quarter basis.

† Listed as a public institution because college of engineering, college of agriculture, college of home economics, and veterinary college receive federal or state aid or both.

TABLE III—*Continued.*

GRADUATION REQUIREMENTS IN MECHANICAL ENGINEERING IN 22 PRIVATE INSTITUTIONS, 1924–1925.

Names of Institutions.	Total Semester Hours.	Total Prescribed Semester Hours.	Total Elective Semester Hours.	Mathematics.	English.	Physical Science.	Social Science.	Foreign Language.	Physical and Military Training.	Miscellaneous Subjects.	Non-Engineering Electives.	Mechanical Engineering.	Other Engineering.	Engineering Electives.	Total Non-Engineering.	Total Engineering.
1. Yale University	138	126	12	12	12	17	12	0	0	0	(12)	39	34	12	53	85
2. George Washington University	140	132	8	12	6	20	8	6	0	0	0	41	39	8	52	88
3. Catholic University of America	173	173	0	22	12	22	1	6	0	14[1]	0	52.5	43.5	0	77	96
4. Howard University*	171.6	171.6	0	20	10	16.6	10	0	15	0	0	63.3	36.6	0	71.6	100
5. Armour Institute of Technology	179.5	176.5	3	18	9	25.5	10	0	0	4	0	65	45	3	66.5	113
6. University of Notre Dame	160	157	3	23	10	24	3	0	—	14	0	44	39	3	74	86
7. Rose Polytechnic Institute	143	143	—	17	8	15	0	10	4	0	—	41	46	—	56	87
8. Johns Hopkins University	161	160	1	22	10	22	6	8*	—*	0	—	46	46	1	68	93
9. Harvard University	108	96	12	12	6	12	6	0	0	0	12	24	36	—	48	60
10. Massachusetts Institute of Technology	170.5	166.5	4	12	12	28	3	0	12	0	0	57	42.5	4	67	103.5
11. Washington University (St. Louis)	146	134	12	17	8	20	6	0	4	0	0	47	32	12	55	91
12. Princeton University	145	133	12	12	8	23	14	12	2	0	0	26	36	12	71	74
13. Polytechnic Institute of Brooklyn	182.5	178.5	4	17	13	21.5	14	—	5	0	0	65	43	4	70.5	112
14. Clarkson College of Technology	143.3	143.3	0	18	6	26	14	0	4	0	0	46.6	28.6	0	68	75.3
15. Syracuse University	159	157	2	18	8	18	3	0	0	0	0	72	38	2	47	112
16. Case School of Applied Science	167	167	0	18	12	21	2	12	7	0	0	60	35	0	72	95
17. Lehigh University	163	163	—	17	9	16	6	6	12	4	0	58	35	0	70	93
18. Lafayette College	142	130	12	17	9	18	6	4+		8[2]	—	35	33	12	62	80
19. Bucknell University	149	144	5	17	6	30	0	12	0	2	0	32	45	5	67	82
20. Swarthmore College	148	133	15	19	10	22	—	12	0	6	6	31	39	9	69	79
21. Carnegie Institute of Technology	139.6	136.6	3	18	6	18	3	0	4.6	9	0	49	29	3	58.6	81
22. University of Pittsburgh	154	154	0	14	14	26	7	0	10	7	0	52	24	0	78	76

[1] Philosophy, Religion.

[2] Bible.

* Figures reduced to semester hours from a term or quarter basis.

study of mechanical engineering. Other omissions are due to lack of satisfactory data.

PART IV.

Summary and Analysis of Graduation Requirements in Mechanical Engineering.

1. *Total Graduation Requirements in Mechanical Engineering.*

There are 47 different cases of Total Graduation Requirements in Mechanical Engineering in the list of 76 colleges of engineering included in this section of the study. These totals vary from 108 to 184.7 semester hour credits.

The tables following give in terms of semester hour credits the principal frequencies or modal tendencies of the "total graduation requirements in Mechanical Engineering" in 54 public and 22 private institutions; also the minimum, maximum, and median figures.

Total Graduation Requirements.

Number of Cases.	In Public Institutions.	In Private Institutions.	Number of Graduation Requirements in Sem. Hour Credits.
1	0	1	108
4	4	0	120 to 128
10	8	2	130 to 139.6
27	19	8	140 to 149
13	11	2	150 to 159
14	10	4	160 to 169
5	1	4	170 to 179.5
2	1	1	182.5 to 184.7

Minimum, Maximum, and Median "Total Graduation Requirements."

Requirements.	For All Institutions (76).	For Public Institutions (54).	For Private Institutions (22).
Minimum.....	108	121	108
Maximum.....	184.7	184.7	182.5
Median.....	148	146	Bet. 149 and 154

The tables show a modal tendency in the group of 140 to 149 semester hour credits. In the sub-mode group of 130 to 139.6 the public institutions predominate. In the super-mode groups of 150 to 159 and 160 to 169 the public institutions are still predominant.

They also show a tendency on the part of private institutions to require a greater number of hours for graduation than in the case of the public institutions.

2. *Total Prescribed Semester Hour Credits in Mechanical Engineering.*

The tables following show the principal frequencies or modal tendencies in the total prescribed semester hour credits in Mechanical Engineering; also the minimum, maximum, and median figures.

TOTAL PRESCRIBED SEMESTER HOUR CREDITS.

Number of Cases.	In Public Institutions.	In Private Institutions.	Number of Prescribed Sem. Hour Credits.
1	0	1	96
6	6	0	110 to 119
11	10	1	120 to 129
17	11	6	130 to 139
14	11	3	140 to 149
13	10	3	150 to 159
9	5	4	160 to 169
4	0	4	170 to 179
1	1	0	184.7

MINIMUM, MAXIMUM, AND MEDIAN "TOTAL PRESCRIBED SEMESTER HOUR CREDITS."

Requirements.	For All Institutions (76).	For Public Institutions (54).	For Private Institutions (22).
Minimum.....	96	110	96
Maximum.....	184.7	184.7	178.5
Median.....	142	Bet. 138 and 141	Bet. 144 and 154

These tables show a modal tendency in the group of 130 to 139 for both public and private institutions. In the sub-mode group of 120 to 129, the public institutions predominate. In the super-modes of 140 to 149 and 150 to 159 both public and private institutions are more proportionately represented.

They also show a definite tendency on the part of private institutions to prescribe a greater number of hours than in the case of the public institutions.

3. *Total Elective Semester Hour Credits in Mechanical Engineering.*

The tables following show the principal frequencies or modal tendencies in the total elective semester hour credits in mechanical engineering; also the minimum, maximum, and median figures.

TOTAL ELECTIVE SEMESTER HOUR CREDITS.

Number of Cases.	In Public Institutions.	In Private Institutions.	Number of Prescribed Sem. Hour Credits.
22	15	7	0
23	14	9	1 to 9
25	19	6	10 to 19
4	4	0	20 to 29
1	1	0	30.7
1	1	0	47

MINIMUM, MAXIMUM, AND MEDIAN "TOTAL ELECTIVE SEMESTER HOUR CREDITS."

Requirements.	For All Institutions (76).	For Public Institutions (54).	For Private Institutions (22).
Minimum.....	0 or 1	0 or 2.6	0 or 1
Maximum.....	47	47	15
Median.....	6	6	3

These tables show that 29 per cent. of all the schools, 27 per cent. of the public, and 36 per cent. of the private institutions offer no electives in the mechanical engineering curriculum.

Three outstanding frequencies which are significant for both public and private institutions are also shown, namely, 0, 1 to 9, and 10 to 19 semester hour credits. They also show that the public institutions tend to allow more elective work than those which are private.

4. *Graduation Requirements in Mathematics, Mechanical Engineering Curricula.*

The tables following show the principal frequencies or modal tendencies for graduation requirements in Mathematics; also the minimum, maximum, and median figures.

GRADUATION REQUIREMENTS IN MATHEMATICS. PRINCIPAL FREQUENCIES.

Number of Cases.	In Public Institutions.	In Private Institutions.	Semester Hour Credits Prescribed in Mathematics.
8	8	0	16
7	1	6	17
18	13	5	18
16	15	1	20

MINIMUM, MAXIMUM, AND MEDIAN GRADUATION REQUIREMENTS IN MATHEMATICS.

Requirements.	For All Institutions (76).	For Public Institutions (54).	For Private Institutions (22).
Minimum.....	11	11	12
Maximum.....	24	24	23
Median.....	18	18	17

These tables show four distinct groupings in Mathematics with 18 and 20 semester hour credits predominating particularly in the public institutions.

They also show that the public institutions seem to favor one semester hour more in mathematics than the private institutions.

5. *Graduation Requirements in English, Mechanical Engineering Curricula.*

The tables following show the principal frequencies or modal tendencies for graduation requirements in English; also the minimum, maximum, and median figures.

GRADUATION REQUIREMENTS IN ENGLISH.

Number of Cases.	In Public Institutions.	In Private Institutions.	Semester Hour Credits Prescribed in English.
1	1	0	0[1]
15	10	5	6
11	7	4	10
18	14	4	12

[1] University of California requires an examination in English.

MINIMUM, MAXIMUM, AND MEDIAN GRADUATION REQUIREMENTS IN ENGLISH.

Requirements.	For All Institutions (76).	For Public Institutions (54).	For Private Institutions (22).
Minimum.....	0 or 2	0 or 2	6
Maximum.....	20	20	14
Median.....	10	10	9

These tables show that the requirements in English follow three distinct groupings with 12 and 6 semester hour credits predominating.

They also show that the public institutions tend to prescribe one semester hour more in English than the private institutions.

6. *Graduation Requirements in Physical Science, Mechanical Engineering Curricula.*

The tables following show the principal frequencies or modal tendencies for graduation requirements in Physical Science; also the minimum, maximum, and median figures.

GRADUATION REQUIREMENTS IN PHYSICAL SCIENCE.

Number of Cases.	In Public Institutions.	In Private Institutions.	Sem. Hour Credits Prescribed in Phys. Science.
5	5	0	16
14	11	3	18
7	5	2	20
11	8	3	22
6	5	1	24

MINIMUM, MAXIMUM, AND MEDIAN GRADUATION REQUIREMENTS IN PHYSICAL SCIENCE.

Requirements.	For All Institutions (76).	For Public Institutions (54).	For Private Institutions (22).
Minimum.....	12	12	12
Maximum.....	44	44	30
Median.....	20	20	20

These tables show that the requirements in Physical Science follow four distinct groupings with 18 and 22 semester hour credits predominating.

They also show the same minimum and median requirements for both public and private institutions.

7. *Graduation Requirements in Social Science, Mechanical Engineering Curricula.*

The following tables show the principal frequencies or modal tendencies for graduation requirements in Social Science; also the minimum, maximum, and median figures.

GRADUATION REQUIREMENTS IN SOCIAL SCIENCE.

Number of Cases.	In Public Institutions.	In Private Institutions.	Sem. Hours Prescribed in Social Science.
16	13	3	0
22	16	6	1 to 5
14	9	5	6
10	8	2	6.7 to 9
6	4	2	10
8	4	4	12 to 18

MINIMUM, MAXIMUM, AND MEDIAN GRADUATION REQUIREMENTS IN SOCIAL SCIENCE.

Requirements.	For All Institutions (76).	For Public Institutions (54).	For Private Institutions (22).
Minimum.....	0 or 1	0 or 1	0 or 1
Maximum.....	18	18	14
Median.....	6	5	6

These tables show that 21 per cent. of all the institutions, 22 of the public and 13.7 of the private institutions do not prescribe social science. The principal group with positive prescriptions varies from 1 to 5 semester hour credits. The 6 semester hour credit requirement stands next in importance.

They also show that the private institutions tend to prescribe one semester hour more in Social Science than the public institutions.

8. *Graduation Requirements in Foreign Language, Mechanical Engineering Curricula.*

The following tables show the principal frequencies or modal tendencies for graduation requirements in Foreign Language; also the minimum, maximum and median figures.

GRADUATION REQUIREMENTS IN FOREIGN LANGUAGE.

Number of Cases.	Number of Public Institutions.	Number of Private Institutions.	Semester Hour Credits Prescribed in Foreign Language.
57	44	13	0
6	3	3	6
4	3	1	8
2	1	1	10
5	1	4	12
1	1	0	14
1	1	0	16

MINIMUM, MAXIMUM, AND MEDIAN GRADUATION REQUIREMENTS IN FOREIGN LANGUAGE.

Requirements.	For All Institutions (76).	For Public Institutions (54).	For Private Institutions (22).
Minimum.....	0 or 6	0 or 6	0 or 6
Maximum.....	16	16	12
Median.....	0	0	0

These tables show that 75 per cent. of all the schools, 81 per cent. of the public and 60 per cent. of the private institutions do not prescribe foreign language for graduation in mechanical engineering.

The tables also fail to show any positive modal group, and the median figures indicate clearly the negative aspect of Foreign Language as a prescribed subject.

9. *Graduation Requirements in Physical and Military Training, and Hygiene.*

The following tables show the principal frequencies or modal tendencies for graduation requirements in Physical and

Military Training, including Hygiene; also the minimum, maximum and median figures.

GRADUATION REQUIREMENTS IN PHYSICAL AND MILITARY TRAINING, INCLUDING HYGIENE.

Number of Cases.	Number of Public Institutions.	Number of Private Institutions.	Semester Hour Credits Prescribed in Physical and Military Training.
19	9	10	0
3	2	1	2
10	6	4	4
14	11	3	5 to 7.3
12	12	0	8
11	7	4	10 to 16
4	4	0	20 to 21.3

MINIMUM, MAXIMUM, AND MEDIAN REQUIREMENTS IN PHYSICAL AND MILITARY TRAINING, INCLUDING HYGIENE.

Requirements.	For All Institutions (76).	For Public Institutions (54).	For Private Institutions (22).
Minimum.....	0 or 2	0 or 2	0 or 2
Maximum.....	21.3	21.3	15
Median.....	6	7	Bet. 2 and 4

These tables show that 25 per cent. of all the schools, nearly 17 per cent. of the public and over 45 per cent. of the private institutions, do not prescribe Physical or Military Training, etc. The public institutions prescribing these subjects show four distinct groupings with four and eight semester hour credits predominating.

The public institutions tend to prescribe more than twice as much in these subjects as do the private institutions.

10. *Graduation Requirements in Prescribed Miscellaneous Subjects.*

Fourteen of the 76 institutions considered here prescribe certain subjects for graduation in Mechanical Engineering in addition to those already mentioned.

These subjects include Bible, Religion, Psychology, Philosophy, and to a considerable extent Orientation courses.

11. *Graduation Requirements: Non-Engineering Electives.*

Fifteen institutions of the 76 listed definitely allow non-engineering electives as a part of the graduation requirements in Mechanical Engineering. The table following shows the most important frequencies.

GRADUATION REQUIREMENTS: NON-ENGINEERING ELECTIVES.

Number of Cases.	In Public Institutions.	In Private Institutions.	Semester Hour Credits in Non-Engineering Electives.
61	42	19	0
3	3	—	6
5	3	2	12
7	6	1	Other credits

This table shows, in addition to the negative group, positive groupings of 6 to 12 semester hour credits.

12. *Graduation Requirements in Mechanical Engineering: Total Non-Engineering Subjects.*

The following tables show the principal frequencies or modal tendencies in total non-engineering subjects; also the minimum, maximum, and median figures.

TOTAL NON-ENGINEERING SUBJECTS.

Number of Cases.	In Public Institutions.	In Private Institutions.	Sem. Hour Credits in Non-Engineering Subjects.
8	6	2	40 to 49
23	18	5	50 to 59
23	16	7	60 to 69
16	8	8	70 to 79
6	6	0	80 to 90

MINIMUM, MAXIMUM, AND MEDIAN FIGURES: TOTAL NON-ENGINEERING SUBJECTS.

Requirements.	For All Institutions (76).	For Public Institutions (54).	For Private Institutions (22).
Minimum.....	40.7	40.7	47
Maximum.....	90	90	78
Median.....	63	60	67

These tables show two prominent groups in Total Non-Engineering Subjects—from 50 to 59 and from 60 to 69 semester hour credits. The private institutions are proportionately stronger in the next group—from 70 to 79 semester hour credits.

They also show that the private institutions prescribe 7 hours more in non-engineering subjects than the public institutions.

13. *Graduation Requirements in Mechanical Engineering: Total Engineering Subjects.*

The following tables show the principal frequencies or modal tendencies in "Total Engineering Subjects"; also minimum, maximum, and median figures.

TOTAL ENGINEERING SUBJECTS.

Number of Cases.	In Public Institutions.	In Private Institutions.	Semester Hour Credits in Engineering Subjects.
4	3	1	60 to 69
16	12	4	70 to 79
28	21	7	80 to 89
16	11	5	90 to 99
11	6	5	100 to 113

MINIMUM, MAXIMUM, AND MEDIAN "TOTAL ENGINEERING SUBJECTS."

Requirements.	For All Institutions (76).	For Public Institutions (54).	For Private Institutions (22).
Minimum.....	60	65	60
Maximum.....	113	108	113
Median.....	85	84	87

These tables show three distinct groupings—70 to 79, 80 to 89, and 90 to 99 semester hour credits. They also show that the private institutions tend to offer 3 hours more in engineering subjects than the public institutions.

14. *Graduation Requirements in Specific Subjects in Mechanical Engineering.*

The tables following show the principal frequencies or modal tendencies in specific subjects in Mechanical Engineering; also minimum, maximum, and median figures. Specific mechanical engineering subjects include courses in mechanical engineering shop work, thermodynamics, kinematics and machine design, heat engines, mechanics of machinery, power engineering, automotive engineering, industrial management and contracts and specifications; but do not include strength of materials, mechanics of materials, statics, hydraulics, mechanical drawing, descriptive geometry, applied mechanics, etc.

SPECIFIC SUBJECTS IN MECHANICAL ENGINEERING.

Number of Cases.	Number of Public Institutions.	Number of Private Institutions.	Semester Hour Credits in Specific Mechanical Engineering Subjects.
5	3	2	20 to 29
22	18	4	30 to 39
25	18	7	40 to 49
18	14	4	50 to 59
5	1	4	60 to 69
1	0	1	72

MINIMUM, MAXIMUM, AND MEDIAN SPECIFIC SUBJECTS IN MECHANICAL ENGINEERING.

Requirements.	For All Institutions.	For Public Institutions.	For Private Institutions.
Minimum.....	22	22	24
Maximum.....	72	64	72
Median.....	44	42	47

These tables show that the 2 groups, 30 to 39, and 40 to 49, are especially strong for both types of schools. They also

show that the private institutions tend to prescribe 5 hours more in specific mechanical engineering subjects than the public institutions.

15. *Graduation Requirements in Engineering Subjects other than Mechanical Engineering.*

The following tables show the principal frequencies or modal tendencies in "Other Engineering Subjects;" also minimum, maximum, and median figures.

These subjects include engineering, drawing, drafting, mechanical drawing, engineering mechanics, strength of materials, mechanics of materials, hydraulics, descriptive geometry, applied mechanics, surveying, civil engineering, electrical engineering and other subjects which are not specific mechanical engineering subjects.

OTHER ENGINEERING SUBJECTS.

Number of Cases.	Number of Public Institutions.	Number of Private Institutions.	Semester Hour Credits in Other Engineering Subjects.
1	1	0	17
13	10	3	21 to 29
42	30	12	30 to 39
17	10	7	40 to 49
3	3	0	50 to 55

MINIMUM, MAXIMUM, AND MEDIAN "OTHER ENGINEERING SUBJECTS."

Requirements.	For All Institutions.	For Public Institutions.	For Private Institutions.
Minimum.....	17	17	24
Maximum.....	55	55	46
Median.....	36	35	36

These tables show 3 distinct groupings; the strongest being from 30 to 39 semester hour credits in "Other Engineering Subjects." The private institutions show 1 hour more in this requirement than those which are public.

16. *Graduation Requirements in Engineering Electives.*

The tables following show the principal frequencies or modal tendencies in the Engineering Electives of Mechanical Engineering Curricula; also the minimum, maximum, and median figures.

ENGINEERING ELECTIVES.

Number of Cases.	In Public Institutions.	In Private Institutions.	Sem. Hour Credits in Engineering Electives.
27	19	8	0
27	17	10	1 to 9
19	15	4	10 to 19
3	3	0	All other figures

MINIMUM, MAXIMUM, AND MEDIAN ENGINEERING ELECTIVES.

Requirements.	For All Institutions.	For Public Institutions.	For Private Institutions.
Minimum.....	0 or 1	0 or 2.6	0 or 1
Maximum.....	47	47	12
Median.....	5	6	3

These tables show that over 35 per cent. of all the schools, both public and private, approximately, do not allow engineering electives (general options are not included in this statement). The positive cases show two definite groupings of 1 to 9 and 10 to 19 semester hour credits. The tables show also that the public institutions are more liberal with respect to engineering electives than the private institutions.

COMPARISON OF GRADUATION REQUIREMENTS IN MECHANICAL ENGINEERING IN PUBLICLY AND PRIVATELY SUPPORTED INSTITUTIONS.

Analysis of the foregoing tables shows that the private institutions exceed the public institutions in the following requirements for graduation in mechanical engineering, and to the extent indicated, namely:

3 or more semester hours in total graduation requirements;
6 or more semester hours in total prescribed credits;

1 semester hour in social science;
7 semester hours in total non-engineering subjects;
3 semester hours in total engineering subjects;
5 semester hours in special mechanical engineering subjects;
1 semester hour in other engineering subjects.

On the other hand the public institutions exceed the private institutions in the following requirements and to the extent indicated, namely:

3 semester hours in total elective credits;
1 semester hour in mathematics;
1 semester hour in English;
3 to 5 semester hours in physical education, etc.

Both public and private institutions have the same median requirements in Physical Science (20 semester hours). The median requirements of the groups in foreign language, miscellaneous subjects, and non-engineering electives are zero.

SOME ADVANCED IDEAS IN ENGINEERING EDUCATION.

By W. TRINKS,

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The sum total of engineering knowledge has grown so fast and has attained such vast proportions within the last twenty-five years that it is utterly impossible for any department of engineering to impart to students the knowledge commonly accepted as coming within the province of that department. At the same time the secondary schools do not prepare their students for engineering as well as in former times. In consequence, the teaching of "engineering" has been reduced mainly to the teaching of so-called fundamentals: namely, language, mathematics, physics, chemistry, mechanics, knowledge of materials, economics, accounting, and similar subjects. Some descriptive "engineering knowledge" is included in the curriculum, and in the junior and senior years an attempt is made, as a rule, to teach the application of fundamental subjects through a few examples in the engineering branch which the student has selected.

Advanced and specialized engineering education within the chosen field is, in the United States, left to post-graduate study. Very little of the advanced work is taught in the engineering schools; most of it is acquired by the young engineer in practice, either from a student apprentice course or from the study of books and of trade papers or from association with experienced men. The term "trade papers" here is used in the widest sense of the word and includes the transactions of professional societies and scientific papers as well as trade publications proper.

This situation delays engineering progress in so far as American engineers are concerned and results in the importation of many European engineers who not only are willing

to work for low wages but also possess a more thorough and highly specialized knowledge. In explanation of the latter statement it may be remarked that in most European schools the entering freshman is as far along as our average sophomore.

Post graduate, or specialized engineering study by a young engineer is usually quite difficult. Experienced engineers are seldom willing to act as instructors for the younger men, except in a few large companies with regular student apprentice courses. Papers delivered before societies furnish piecemeal, helter-skelter instruction of a more or less fortuitous character.

It may be argued that students who wish to obtain a more thorough and a more specialized engineering education than that ordinarily offered in four-year courses can attend those colleges which offer five or six year courses. Aside from the geographical difficulty of attending a school far from home, there is another objection to this proposal. The long courses are not popular on account of the fact that most young men, when they receive the degree of bachelor of science from an engineering school, have attained an age of twenty-three years and are eager to obtain a position in which they can earn sufficient money for founding a household. After all, man is an animal, and his procreative instincts must be taken into consideration.

Under present day conditions there remains the study of books, but when it comes to providing young engineers with good books dealing with the speciality which they have selected, the engineering colleges, as a rule, fall down, as is evinced by the fact that few high-grade engineering books of American origin are on the market. Not that we lack in text books, but in that quality of books which deepens our knowledge of fundamentals and of their application to engineering specialties. I have reference to books such as Stodola's and Martin's treatises on Steam Turbines, Osterman's book on Turbo-Compressors, Harbold and Hall's Metallurgy, and similar advanced books of European origin from which the student

can help himself and by the conscientious study of which he can climb to the heights of his profession. The reason for the scarcity of good reference books is plain. In the United States those who have enough knowledge and experience to write advanced books are so busy with engineering work that they have no time for the arduous task of writing books. And those who have the time to write them, as rule, have not had the necessary engineering experience to produce good books. Tersely stated, the situation is this: those who know don't tell, and those who tell don't know.

The author has had the problem of advanced and specialized education in mind for a number of years and has discussed it with educators both in the United States and in several European countries. As a result of this thought, study and discussion, the author has come to the conclusion that the universities are not doing their share of work in advanced engineering education. As a possible remedy for this situation, the author offers two propositions which may appear quite radical.

The first proposition relates to the production of good books. The author is convinced that there ought to be two types of books, namely, text books for undergraduate study, and books for advanced study. If we, for instance, take a subject such as Applied Mechanics, it is quite evident that there are many subdivisions in that subject with which an engineer should be familiar but which he can not master during his undergraduate study. I have reference to the theory of torsion of bars other than round, the stream line theory of stress, the theory of hardness, the theory of stress distribution around a discontinuity, the vortex theory of turbo-machinery, the flow of viscous fluids, and many other advanced subdivisions. Similar conditions will exist in all engineering subjects such as machine design, alternating currents, metallurgy, and many others. The proposition, therefore, is that in each subject there ought to exist an elementary text book and a correlated advanced book. The two should be interwoven to such an extent that the advanced book is built up on the elementary

book. The separate books are preferable to a single book because past experience has shown that text books which try to combine both elementary and advanced knowledge have been abandoned in favor of simpler and more elementary text books. There appears to be a double reason for this fact. An elementary text is easily understood in home study, and the price of an elementary book is more within the reach of the students. As previously stated, the result has been that text books containing advanced matter are gradually disappearing from the market and the more elementary books have big sales.

While there is little difficulty in producing simple and elementary text books, there is a real difficulty in producing advanced reference books because the latter require a thorough knowledge of the subject as well as ability to present it both from a practical and from a scientific standpoint.

At the present time too much is left to individual initiative in the production of advanced books. In other words, a good advanced book is written whenever a man of sufficient mental caliber happens to have the time, the inclination, the ability and the knowledge to write a good book on an advanced engineering subject. In this matter, careful systematic selection of authors should be substituted for accident. To this end it is proposed that the Society for the Promotion of Engineering Education, in conjunction with the National Engineering Societies, start a book fund from which authors of books are to be paid salaries for the time during which they write the books. It should, for instance, be possible to pick out a man who has theoretical knowledge of a certain branch of engineering, who has had practical experience in that specialty and who has the ability to present the subject. If this man be a college professor, the college employing him should be asked to give him a year's leave of absence with part pay and he should be employed by this Society, in conjunction with the proper National Society, to write a book on the given subject. The Societies would then pay his additional salary and furnish compensation for reasonable expenses incurred in travel-

ing and in paying for clerical help in the production of the book. The greater part of the royalties from the book could be returned to the Societies.

The second proposition which the author wishes to present refers to specialized education in engineering subjects. For maintaining a leading position among the nations it is necessary that we have in the United States advanced and specialized education in engineering. Taking as an illustration the subject with which the author is most familiar, namely, mechanical engineering, there is no reason why there should not be somewhere in the United States an excellent school making a specialty of steam turbines, with instruction in that subject at least equal to that given by Dr. Stodola in Zurich. At some other institution the subject of machine tools should be taught intensively, still another institution might specialize in hoisting and conveying machinery, etc. To this end the United States could be divided into districts, and certain schools could be selected for instruction in specialties. The selection could be based partly on geopraphical location close to certain industries and partly on the equipment and teaching staff which the colleges already have for teaching certain subjects. It may be desirable to have two institutions, far apart geographically, teach the same specialty.

Highly specialized instruction in engineering should not begin until the student has earned his bachelor of science degree and should be given in such a manner as not to interfere with the daily and practical work of the young engineer. To this end these courses could be taught largely by correspondence and only partly by personal attendance of the students (in residence). While correspondence instruction has its shortcomings and has a bad reputation on account of its often superficial character, it can be made thoroughly effective if the student has already mastered the elements of the subject and has a firm foundation on which to build. While most students would prefer correspondence instruction, a few would prefer to study in residence. For the benefit of the large numbers who study by correspondence special short sessions

with personal attendance should be held. These students could arrange their vacations to coincide with the time of the special sessions, and spend three or four weeks each year at the university in close personal contact with the teaching staff, preferably in seminar and laboratory instruction. The author understands that similar methods are now followed by the medical profession.

Sooner or later the two universities teaching a special subject would become central sources of information for that subject in the United States, and the teaching staff would be kept abreast of the times by give-and-take between school and industry, by research work, and important consulting work. By such an arrangement each university or other technical institution would have one specialized, well-equipped laboratory and a few high-grade engineering teachers,—and expensive duplication would be eliminated.

Selective teaching of advanced specialties would wonderfully simplify the teaching of undergraduate courses and would allow an increasing amount of standarization as well as of interchangeability of instruction between the different colleges. This feature is of the greatest importance. With excellent engineering books at our disposal and with inexpensive, specialized instruction available beyond the bachelor's degree, undergraduate instruction can be made more fundamental. Petty descriptions of equipment and study of routine duties now deemed necessary, can be eliminated. The courses can be made more general and the first two years in all engineering colleges can be made identical for all engineering students. It may be too radical to suggest elimination of the various bachelors' degrees and to recommend only one degree, namely, bachelor of science in engineering, but the proposed plan would work in that direction.

Advanced instruction should not be confined to engineering specialties but should include opportunity for extension and intensification of the young engineer's knowledge of mathematics, physics, mechanics, materials and physical chemistry.

Evening instruction in colleges is thoroughly practical if limited to undergraduate subjects, but can not take the place

of the proposed plan because highly specialized evening instruction is local and, therefore, expensive. It results in teaching many specialties to a very small number of students in each subject, whereas the proposed plan would result in each school having but one, and certainly no more than two specialties, with the whole United States as a field from which to draw students.

Both propositions, namely the writing of advanced books by selected specialists who receive a salary for writing the book, and the selective distribution of the post graduate teaching of engineering specialties among the colleges are based on closest coöperation between the administrations of the various colleges, our engineering societies, and also between members of the Society for the Promotion of Engineering Education. The danger exists that each professor with some knowledge of an engineering specialty will believe himself to be the one who should be selected to write an advanced book. And the faculty of each engineering college may feel that its own college should be selected for teaching all the advanced specialties. The plan can only succeed by each college giving up some engineering subjects and concentrating more heavily upon one single specialty.

The author is convinced that our undergraduate engineering education, as now conducted, lays a good foundation but that, if we are to advance in engineering education with maximum effect at minimum cost, we will have to come to educational methods such as are outlined in this paper. The question is whether or not professional jealousies between various men and various institutions can be restrained sufficiently to make this plan feasible and practical in the near future. A second question is this: can we establish a centralized organization with a sufficiently big man at the helm to put these plans into effect, and, what is even more difficult, to keep them operating smoothly? In this connection it should be mentioned that the United States is fortunate to have the Society for the Promotion of Engineering Education, the members of which are sufficiently interested in progress to subordinate their own ambitions to the general welfare.

AN ELECTRICAL "LABORATORY-PROBLEM" COURSE FOR FRESHMEN AND ELECTRICAL ENGINEERING STUDENTS.

By EARL B. STAVELY,

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This article describes an electrical "laboratory-problem" course given to freshmen and sophomore electrical engineering students at The Pennsylvania State College. The purpose of the course is, in general, the same as that of the engineering problem courses which have been introduced into the curriculum of the Freshman year at many engineering colleges. The course is presented in a suitably equipped laboratory, rather than in a class room or calculation room, hence certain features of the work differ very considerably from those of the problem courses just mentioned.

Character of the Work.

The course consists of a series of exercises each of which requires two types of problem work—(1) a study of methods previously employed by engineers in the solution of certain problems, and (2) the solution of simple "new" problems.

The instructions for each exercise include a description of an electrical engineering problem which has previously been solved by electrical engineers, an outline of the facts which caused that problem to arise, and a discussion of the requirements which had to be met in its solution. Specially prepared equipment of the type referred to in this problem is provided in the laboratory. The student is required to determine, by a suitable investigation of this equipment, how the problem was solved and to study the methods employed in its solution. This investigation may involve a study of construction, a study of principles of operation, the conduct of certain ex-

periments and tests, and the calculation of certain data. The student is guided in this work by an outline of questions, topics for discussion, data, etc., which are to be covered in notes which he is required to submit at the end of the period.

The second part of the exercise requires the solution of comparatively simple problems which, to the student, are new problems. These deal with the equipment which was considered in the first part of the exercise, and are so designed that in their solution the student must apply the information and data obtained in the preceding work, and in many exercises must carry out additional tests and investigations on the laboratory equipment.

Scope of the Course.

The scope of the course is indicated in the description of the laboratory equipment given later. The work is, of necessity, quite elementary in character but it introduces the student to many topics which could not be readily presented in a simple problem course. The course deals with nearly all of the more common types of electrical equipment, but is not intended to replace any part of the technical work of the Junior and Senior years or of the work in Physics of the Sophomore year.

Laboratory Equipment.

The laboratory occupies a room with a floor space 50 by 75 feet. It has been specially equipped for this course, and is used for no other purpose.

Standard commercial equipment has been specially prepared and installed for use in the investigations and tests required in this type of problem work. Numerous charts, blue prints, photographs, manufacturer's bulletins and similar descriptive material are also provided for use by the student.

This apparatus and material has been permanently installed in the laboratory, hence the student is surrounded on all sides by "things electrical." The atmosphere thus created appears to have a marked effect upon the character of the work done by the student.

The equipment may be divided into groups, relating to different subjects, as follows:

1. *Principles of Electricity and Magnetism.*—Details of common electrical devices arranged for the conduct of simple experiments illustrating these principles.

2. *Construction of Dynamo Machines and Transformers.*—Complete sets of parts showing construction details; machines cut in section to show assembly of parts; machines for partial disassembly, measurement, etc.

3. *Machine Testing.*—Motors, generators, and transformers with test tables.

4. *Machine Installation and Operation.*—Sample motor installations with complete control equipment, and generators with standard switchboards, for study of installation and routine operation.

5. *Control Devices.*—Manually operated motor control devices specially prepared for investigation of construction, connection, and operation; several types of automatic control equipment in "exploded form."

6. *Switches and Protective Devices.*—Samples of the more common types prepared to show construction and principle of operation; samples for test, calibration, etc.

7. *Measuring Instruments.*—Displays showing construction details and principle of operation of different types; apparatus for simple tests and calibration.

8. *Insulating Materials.*—Samples of various types; equipment parts showing application of each type.

9. *Wire and Cable.*—Samples of various types; equipment showing application of each type.

10. *Batteries.*—Displays showing detail parts and manufacturing processes; batteries cut in section to show assembly of parts; apparatus for simple tests.

11. *Lighting.*—Various types of lamps; apparatus for simple lamp tests; displays showing details and manufacturing processes; shades, etc.

12. *Power Distribution.*—An alternator, transformers, and apparatus for duplicating lines and loads for use in a study of simple distribution problems.

13. *Telephones.*—Equipment details prepared for a study of construction and principle of operation; magneto and common battery two party systems, with exchange equipment, arranged in "exploded form"; intercommunicating system.

14. *Electrical Construction.*—Samples showing each step in splicing wire and cable, making electrical connections of various kinds, preparing conduit, etc.; supplies and tools for actual manual work of this kind by the student.

15. *Interior Wiring.*—A number of small rooms, built of standard

building materials, each of which is wired to show the methods employed in one type of interior wiring.

Typical Problems.

A brief outline of a few problems will be given here in order to describe more fully the character of the problem work.

In one exercise the student studies the methods employed in the development of knife and oil switches for various kinds of service. He then designs a switch for a specific purpose, using data obtained in the preceding work, makes various special switch connections and checks these by trial.

Another exercise deals with problems arising in the application of wire and cable in certain classes of service. The problems for solution by the student introduce him to circular mil measure, wire tables, and calculation of resistance.

An exercise dealing with the construction of direct current dynamos requires a study of certain design and manufacturing problems relating to such details as brush holders, coils, commutators, and bearings. The student then partially disassembles a machine, obtains by measurement the data necessary in filling out a Design Data Sheet, and then solves problems dealing with areas, volumes, weights, and velocities of parts of this machine.

Another exercise involves a study of a typical industrial application of shunt wound motors. The problems for solution by the student require calculations of efficiency, cost of energy under certain conditions of loading, yearly fixed and operating costs, etc., necessary data being obtained in part by the conduct of a test on a motor of this type.

General Discussion.

It is believed that the student obtains a fairly clear conception of the nature of engineering by this study of the methods previously employed in the solution of specific engineering problems.

It is possible to put the work into such form that the student is constantly reminded of the fact that engineering problems

are rarely solved by the simple application of formulas and short cut methods but that logical thought, common sense, good judgment, and careful analysis must be employed throughout the work of the engineer.

The importance of the fundamental principles of engineering is stressed throughout the course in order to encourage the student to obtain the best possible knowledge of these principles in the courses in mathematics and science of the first two years.

Considerable preparation is given by this course for the technical work of the Junior and Senior years since the student obtains a fair knowledge of the construction and operation of many types of electrical equipment and of various simple engineering devices and methods which are applied in the later technical work.

It is believed that in the solution of a comparatively small number of problems, involving work of the type described previously, the student receives a type of training which is not possible in a course presenting numerous problems involving mathematical work only.

In designing the problems it has been found possible to give the student many opportunities to apply his imagination, common sense, judgment and individuality.

The introduction of the laboratory feature adds considerable "life" to the most simple problems, an element which has been found to have a marked effect upon the character of the work done by the student.

All engineering students at this College are required to spend at least six weeks of each summer vacation in some form of industrial work. The work of this course should give the student considerable preparation for practical work in electrical activities during these vacation periods.

The course appears to possess marked possibilities as an aid in vocational guidance. The contact with engineering problems and equipment tends to place the student in a position where he can determine for himself whether his interests

naturally lie along engineering lines and whether he possesses natural aptitudes for engineering work.

This method of instruction has been in use for only a comparatively short time, hence is still in a process of development. The results thus far obtained indicate that the course may be made an important part of the electrical engineering curriculum.

THE ENGINEERING COURSE AS A GENERAL EDUCATION.

BY E. WILLIS WHITED,

Associate Director of Coöperative Work, University of Pittsburgh.

The engineering course is being recognized more and more as an excellent system for a general education and is being pursued by an increasing number of students who never intend to follow engineering as a profession, or, at least, do not follow it. The principal explanation of this fact is that the type of mental training given in the engineering course fits a man for a large number of vocations in life, even outside of engineering. A second reason, but by no means less important, is the well known fact that engineering courses are kept fully abreast of the times, if not a little in advance, so that the student is assured of receiving a modern education. For these reasons, the curriculum must be the subject of constant study to be certain that it is meeting the needs of the students who follow it.

Mathematics is taught engineering students early in their course for two reasons: first, because of the mental training that the student receives from its study in the abstract; and second, because it is required in subsequent courses. Of these two reasons, the former is usually given the greater weight.

Considering its necessity in later courses, mathematics, as taught, can be divided into two parts. Elementary subjects, including trigonometry and analytical geometry; and intermediate subjects, including the calculus and sometimes differential equations.

The elementary subjects are obviously essential, trigonometry for its basic qualities, and analytical geometry for its treatment of curves. But the necessity of the calculus in later courses is not so self-evident. It is based largely on the study of hydraulics, mechanics, and the strength of materials.

Ten years ago there were no text books of repute on these subjects which did not require the calculus. To-day, however, hydraulics is being taught to students who have never completed a course in the calculus, a course in the strength of materials is being prepared now for students who will not be required to study it, and mechanics is being taught concurrently with it. Clearly, the calculus cannot be of much service in the study of mechanics, if this be the case, and it should be a comparatively simple step to develope this course a little further and eliminate the necessity of it altogether. Differential equations were abandoned some time ago as a prerequisite for undergraduate engineering courses and are taken now by students who expect to specialize in higher design only.

The elements of mental training which the student receives from the study of mathematics consist principally of logical thinking, accuracy, resourcefulness, the development of the imagination, and the satisfaction of a job well done. These phases are emphasized by giving the student a great many problems to solve of varying degrees of difficulty. For these reasons, mathematics could well be studied by all students, and not by engineers exclusively.

Turning now to the use of mathematics made by the graduate engineer, a study of their activities should give valuable information. Roughly, the work which these men do can be divided as follows:

1. Pure engineering, designing and research, requiring the use of the calculus about ten per cent.
2. General engineering, construction and operation, not requiring the use of the calculus, about twenty-five per cent.
3. Other professions, not requiring the use of the calculus, about five per cent.
4. General business, merchandising, manufacturing, etc., not requiring the use of the calculus, about thirty-five per cent.
5. Lines unallied to engineering or special activities, not requiring the use of the calculus, about twenty-five per cent.

From the above it is seen that not more than ten per cent.

of the students who take undergraduate engineering courses ever have occasion to use the calculus in later life. Again, upon studying the men who make a success in every day life, it will be found that they fall in two classes: the law trained man, and the man trained in finance, and of these two, the former predominates. This seems to be so because law is the rule of life set up by society for its own guidance and the expert in law would naturally become a leader for that very reason. And it might be added that whenever a man trained in finance becomes a prominent leader, he will generally be found to be familiar with the fundamental principles of law. There are, of course, successes in all walks of life, including engineering, but at the present time, the large majority of our leaders are drawn from these two groups of men. One of the essentials in the mental make-up of a successful man, is the ability to think logically and accurately and quickly and to make decisions promptly. These elements are inbred in the engineer, perhaps even more so than in the lawyer or the financier, because the engineer knows that his mistakes are likely to be more or less permanent and public. Perhaps it is for this reason, that there is an ever growing tendency, now, for the man trained in engineering to rise, and assume some of the larger responsibilities of public life. They seem ideally suited for this work, due to the very nature of their training. Indeed, when the opinion of the engineer and the politician differ, it will usually be found that the opinion of the engineer will survive. Men who graduated from engineering schools forty years, ago, found it to their advantage to conceal that fact, while now conditions are exactly the reverse, which serves to show the rise in public respect for the engineer.

It would seem then, that the responsibility of the engineering schools is becoming heavier and heavier as the value of the man trained in engineering becomes better and more widely known and his responsibities increase. For these new duties, the engineer has no use for the calculus as such, but he does need the mental training he receives from its study more and more.

It is a well known fact that the calculus is very difficult for a large proportion of the engineering students. This may be because it is of an entirely different nature from any of the mathematics the student has had before, and brings in, perhaps for the first time, the necessity of using the imagination, which heretofore he may have thought belonged to the realm of the artist. Perhaps it is because the theory of the calculus depends upon what appears to him to be an approximation which is entirely at variance with all his previous training. Whatever the reason, many students find it so difficult that they lose sight of the major object of its study and become absorbed in the mechanical solution of specific problems. Thus they lose interest, and, as a result, the value of the mental training they receive is reduced very greatly. Our present standards require that the engineering student secure the mental training arising from the study of the calculus and our measure of his success in securing this training is his ability to complete a course in this subject satisfactorily. And moreover, if he does not complete this course satisfactorily he is told that, until he can and does complete it, he will not have the proper mental training to fit him for the engineering degree.

As the engineer is assuming more important responsibilities in public life and service every day, most of which are only remotely connected with the engineering profession, but which can be done best by a man trained in engineering, it would seem that the practice of setting up a course in the calculus as an essential measure of this training might be of doubtful wisdom. On these grounds, therefore, that it is of no use to ninety per cent. of engineering graduates in later life, and that such a large proportion find it very difficult to obtain the proper mental training by this means, it would seem advisable to substitute another subject, provided one can be found that will bring about the same results as the calculus. At the same time, it must be realized that it will be useless to look for any other subject intrinsically easier than the calculus to accomplish this purpose. However, one might be found, the me-

chanics of which would be harder for the mathematician, yet would be easier for the non-mathematician; that, while giving the same mental training, would be free of mathematics, and thus give the non-mathematician a chance to secure this training. It must be borne in mind that the calculus is here considered as a vehicle for this mental training and not an end in itself. For the man who intends to specialize in design or research, there is no substitute for the calculus.

There are two subjects which present themselves for consideration as a substitute for the calculus, and which contain all the attributes for mental training possessed by it, although both of them are much more difficult for the average student to master. These are logic and the law. A course in logic, to be the equivalent of one in the calculus would require so much preparation in the form of underlying courses in order to master its methods, that it would be necessary to delay it until the third or fourth year. This is too late in the course for the student to reap the benefits of its study while still an undergraduate. And even if this objection could be overcome, the average university underclassman is too immature to undertake its study successfully.

Turning now to the study of the law. The study of law requires logical thinking, accuracy, and resourcefulness and it develops the imagination to a marked degree. While in the writing of a brief of a case, the student gets the same feeling of a job well done as comes from the solution of a problem in the calculus. If the study were confined to commercial law, it would be intrinsically useful in later life to a large number of the students who have studied it as engineering undergraduates, an advantage which the calculus does not pretend to have.

But it must be studied even more seriously and be taught as efficiently as the calculus is now, and it should be required as a prerequisite in the same places even more rigidly. It should be taught, not by engineers trained in law, but by members of a law school faculty, who, perhaps, might not know, or at least, give no consideration to the fact, that they

were teaching engineering students. In other words, a mere elaboration of the usual course of "Law for Engineers" would not suffice. It should not be a lecture course given twice a week, but a recitation course given four or five times a week, and supplemented by constant reference to case books, from which the student would be required to brief a large number of cases. And finally, they should be given some practice in actually arguing and trying cases, to accustom them to making quick and accurate decisions, to separating correct from incorrect arguments, and to consider all the relevant facts in a given case. These last three things, mathematics is not able to do.

For these reasons, therefore, that the study of the calculus is not necessarily a prerequisite for subsequent engineering courses, that it is of no value intrinsically to ninety per cent. of the students taking it, that it is peculiarly difficult for a large majority of these students, that the study of commercial law will give better mental training and that it will be of practical use to a large number of students, it would seem advisable to consider the substitution of a thorough course in commercial law for all or part of the calculus given in the course in mathematics to all engineering undergraduates, except those who expect to specialize in design or research work.

REASONABLE DEMANDS UPON STUDENTS' TIME.* A BRIEF REVIEW OF AN INVESTIGATION OF THE CURRICULA OF THE VARIOUS DEPARTMENTS IN THE COLLEGE OF ENGINEERING AND COMMERCE OF THE UNIVERSITY OF CINCINNATI.

BY PROFESSOR E. S. SMITH,

University of Cincinnati.

I believe that we will all agree that student traditions and faculty traditions are essential in the operation of all colleges, and I can say that we have traditions in the College of Engineering and Commerce of the University of Cincinnati such as all colleges have. I think you will also agree with me that we should be careful not to become so bound by traditions that we cannot discard traditional methods when they cramp our activities. Our faculty at Cincinnati is as little bound by traditions as a faculty can be. We do not believe that because it is traditional to do a certain thing a certain way that that is sufficient justification for doing it that way, and if we can find a better way of doing it we do not hesitate to make all necessary revisions.

The state of mind which enables us to look at all problems affecting the policies of our college under the glaring light of present day needs is a result of the kind of studies which we undertake in our faculty meetings. No faculty which meets with Dean Schneider as the presiding officer is in danger of holding to outworn traditions, nor are its members in danger of getting into ruts and complacently conducting classes in the same old way year after year. So far as possible he has routine matters such as student petitions, questions regarding grades and all such questions which make faculty meetings so dull, considered by special committees, and then he brings to our faculty meetings problems of education

* Presented at Ohio Section, S. P. E. E.

particularly as they affect our college. These faculty meetings are far from dull. I could name many interesting questions which we have discussed, and also many of the investigations into the work of our college, which we have conducted as a result of the problems which have been discussed in faculty meetings, but if I give a brief outline of the investigation which we have been conducting during the past few months you will see at least what our investigations are like.

There are two features of our meetings of this winter which we believe will be of interest to you. The first deals with the method of conducting our faculty meetings, in which method we have discarded one of our oldest traditions or customs. During the past few months the faculty meetings have been limited to the Instructors, Assistant Professors and Associate Professors, excluding all Professors and Department Heads. The second phase deals with the investigation of the curricula of the various departments, which this Junior faculty has conducted.

We have had a condition in our faculty meetings which may be the result of tradition, and again it may be due to force of circumstances. A few of the professors have been monopolizing all of the time which could be devoted to discussions, and the rest of the faculty, excepting for an occasional timid soul who, no longer able to hold back his ideas, has launched himself into the midst of the select few, have furnished the audience. Doubtless this condition does not confront any of you, although it seems almost inevitable that such a condition must exist in a large faculty, for it is a natural and logical one. There is not even an intimation of criticism, in anything that I shall say, of the professors who use up the major portion of the time at the faculty meetings, for these men are men of broad training who have had extensive experiences in the fields of education and engineering, and their contributions to any discussion are of great value. Dean Schneider appreciates that fact, and he has had no desire to limit the free discussion of all topics, but he thought that he was losing something by not having a greater number of men participating

in the meetings. He was desirous of hearing the thoughts of the newer men, and was particularly anxious to hear from the young instructors. In order, therefore, that he could be benefited by the thoughts of both groups, he divided his faculty into two parts, the Professors (about twenty men) met with the Dean as an Executive Committee, while the Associate Professors, Assistant Professors and Instructors (about fifty men) met with him as the younger or Junior faculty.

The Junior faculty meetings were carried on as regular meetings for the discussion of problems that were pressing for solution. Doubtless the solutions would have been very much the same if obtained by the general faculty, and it is quite significant that the Junior faculty could carry on as though they had been doing so all along. Dean Schneider led the meetings of this younger faculty, until he had directed the discussion through various problems to the big problem which he wanted solved, namely: "To make a study of the curricula of the various departments to determine whether or not an average student can properly prepare for all of his recitations in a reasonable time." He did not think that our course was too difficult for our students, but he did think that it might be too "laborious." He wished to find out if the students were required to do too much "hack" work, and also to determine if we had culled out enough of the old material to make room for the new material which we were continually adding to our courses, as we kept pace with the developments of science and the applications of science to engineering. If we found that the situation was not satisfactory then we must formulate remedial measures.

The faculty agreed to undertake the investigation, and we were then confronted with a real problem. How could we get a fair estimate of the time which students should spend in preparation for their school work? Obviously, the only way to find out how long it takes to do a thing, is to do that thing. Therefore the faculty must needs become students and actually prepare for the recitations just as we require our students to prepare, or rather as we expect the students to prepare.

The Committee on Statistics was instructed to conduct the investigation and was given power to appoint all necessary sub-committees. During the month of the investigation Dean Schneider turned the faculty meetings over to the investigation, and authorized the Chairman of the Committee on Statistics to act as Chairman of the meetings. Every member of the junior faculty was appointed on a committee; 19 committees in all. There was one committee for the first year (the courses of the first year in all departments being alike), two for the second year (the courses of the Commerce Department being different), five (one for each department) for each of the last three years, and an additional committee on grades, which made a study of the grades received by all students in our college during the first semester of this year.

It was the duty of each committee to investigate the material to be covered during the second semester in all courses taken by the students of the group being investigated by that committee. Take, for example, the committee investigating the courses for the students of the third year in the Department of Chemistry. This committee first obtained from the office a list of all subjects which these students are taking this semester. The committee then visited each of the instructors who are teaching these various subjects and obtained from them an outline of the work to be covered during the semester, and, so far as possible, the distribution of this work by weeks. The instructor giving a course discussed his work with the committee investigating it, and explained how he conducted his lectures, what he expected of the students, and endeavored to give to the investigators the knowledge of this subject which the student should have as he prepared for a recitation. This was particularly necessary because many of the men were investigating courses that were quite out of their own field. However, each committee had one member who represented the department most directly concerned. The instructor giving a course stated his estimate of the time which a student should require in preparation for that course.

The investigators spent four weeks studying the contents of

all courses taken by the students of the group being investigated by them. Each member of the committee read, as though in preparation for a recitation, enough of the assignments in each course to be able to make an estimate of the work of the whole semester. The time taken by the investigators in preparation for a recitation, and the time which the instructor giving the course estimated the students should need, were used by the investigators in making their estimates of the time which students should take.

The committee then studied the laboratory courses and found that it was more difficult to estimate the time which students should require in writing laboratory reports, but a form was drawn up and by filling in this form, in consultation with the instructor giving the laboratory course, and by reading some of the reports which were submitted by the students, a sufficiently reliable estimate of the time required in writing the reports was obtained, for the Committee on Statistics to determine the influence of laboratory courses on the general problem which we were studying.

The other committees of investigators followed the same plan.

The committee on grades made a study of the grades received during the first semester, and the graphical analysis of these grades furnished an excellent means of checking individual courses. The data were supplemented by obtaining the actual number of hours which students in each course required in preparation. These hours were obtained from the students by their coördinators (the coördinator for a department is the faculty member who is in charge of the factory work of the students of that department). The coördinators were very careful to pick students of average ability on whom they could rely to furnish us with correct information. However, these data were only obtained from a few students of each department and did not furnish an accurate average of the time students took to prepare their school work.

The Committee on Statistics studied the reports of the investigators and through this study found that our second year

and third year students are very heavily crowded, but that the students of the first year, fourth year and fifth year, while having enough to do, should be able to prepare all outside work in a reasonable time. It was quite obvious that the serious over crowding was due to the excessive time spent, outside of laboratory periods, in writing laboratory reports. It was gratifying to find that in the main the lecture courses were not making unreasonable demands upon the students' time. In regard to lecture courses a slight reduction of the assignments in a few cases, and a redistribution of the work over a couple of years in other cases, would take care of the overcrowding. The remedies were then simple—require all laboratory courses to be completed within the laboratory periods, and limit our assignments for lecture courses so that a student would not require more than 3 hours per night to prepare for all of his lectures satisfactorily. As our students are scheduled for work daily from 8:30 A.M. until 5:00 P.M. (Saturday 12:30 P.M.) it would seem unreasonable to ask them to spend more than 3 hours per night or 18 hours per week, in preparation for their school work. Therefore, at the meeting of the general faculty a week ago the faculty adopted a definition of credit hours which should make it possible for a student to confine his outside school efforts to that number of hours.

There is an additional phase of this whole investigation that is interesting. In order to get the student's point of view the Committee on Statistics held several meetings with a group of students who were picked by the president of the student Tribunal (our student governing body). The discussions were very free and were participated in very generally by the students present. The suggestions for the work of the first two years were usually detail questions, particularly with regard to text books, showing where texts were difficult and why students had trouble with them—indicated in most cases that the freshmen and sophomores were unable or unwilling to think things out for themselves. The faculty point of view helped these fellows. The suggestions from the upper classmen were more constructive, and dealt with such questions as

the relative value of special problems instead of these, and other questions of equally broad vision. The contact between faculty and students was very much worth while, and the committee expects to propose that such discussions be undertaken every year.

DISCUSSION.*

C. D. BILLMYER,

Atlas Portland Cement Company, Allentown, Pa.

I wish to supplement Mr. Andrews' very commendable paper by a few observations from my own brief experience as a teacher. My first teaching engagement followed two years of industrial work of no great value to a prospective teacher. In all fairness, I must state that although evidently satisfactory to others, my first efforts as a teacher were very unsatisfactory to me.

My next four years of teaching followed a period of very valuable industrial experience—valuable not so much on account of the duration of this experience as on account of the great variety of problems encountered, and the amount of responsibility shouldered. The success which attended my efforts and the whole-hearted responses from my students were very gratifying to me. I do not believe that I could have secured the same beneficial results by spending an amount of time equal to this second period of industrial work, in advanced study or academic research. Of course, one must not lose sight of the fact that to succeed in industrial work, an engineer must very often devote quite as much of his time to study as his contemporary engaged in advanced collegiate work.

I believe that in the selection of teachers, too much emphasis is given to the acquisition of advanced degrees, instead of some other very necessary qualifications. Teachers with a very profound knowledge of a subject, often lack the ability to impart it to others or the personality with which to draw the proper response from their students. In many cases, this is due to lack of industrial experience. To be successful, the young engineer of the future needs more than ever before, a

* W. O. Andrews, "The Value of Engineering Practice to the Teacher of Engineering," *Journal of Engineering Education*, March, 1926.

very rigorous training in engineering theory; yet it is very difficult to inspire in the student a liking for abstract theory unless the teacher is able to point out, from his own experience, useful and interesting applications of this theory.

My own experience leads me to the conclusion that some industrial experience is extremely valuable to a teacher, while some other is practically worthless. It seems to me that the proper relative values to be assigned to academic and industrial work, must be determined in each case by the actual conditions involved rather than by establishing an inflexible rule.

CORRECTION.

NOTE CONCERNING THE PRELIMINARY REPORT OF IOWA PLACEMENT EXAMINATIONS WHICH APPEARED IN THIS JOURNAL, MARCH, 1926.

Through error the scores of seventeen students at the University of Pittsburgh who had not previously taken Physics were included in the tabulation of Physics Training scores. The correct values for University of Pittsburgh are as follows:

No.	Mean.	Median.	Upper Quartile.	Lower Quartile
26	52.12	42.50	56.67	31.88

GEORGE D. STODDARD.

SCIENTIFIC AND ENGINEERING SYMBOLS AND ABBREVIATIONS.

The American Engineering Standards Committee has organized a Sectional Committee on Scientific and Engineering Symbols and Abbreviations. The sponsors for the standardization of scientific and Engineering symbols and abbreviations are the following:

The American Association for the Advancement of Science
The American Institute of Electrical Engineers
The American Society of Civil Engineers
The American Society of Mechanical Engineers
The Society for the Promotion of Engineering Education

The scope of the work of the Sectional Committee is defined as follows: "A broad program of unification of graphical symbols, and symbols for quantities in equations and formulas, and of abbreviations, as used in engineering and scientific reports, tables, publications, etc.; but not including definitions of terms used in engineering and scientific practice."

The officers of the Sectional Committee, elected January 21, 1926, to serve for two years, are the following:

J. F. MEYER, *Chairman*
S. A. MOSS, *Vice-Chairman*
PRESTON S. MILLAR, *Secretary*
S. McK. GRAY, *Assistant Secretary*

Subcommittees for the seven subjects mentioned below were established, and a temporary chairman for each subject was selected, whose name is shown.

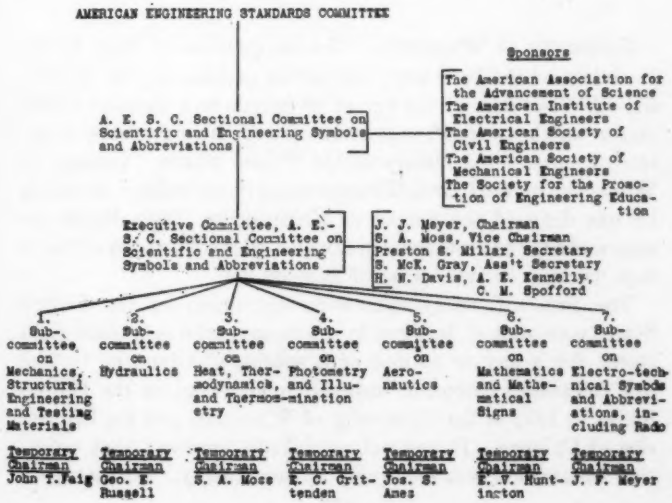
1. Mechanics, Structural Engineering, and Testing Materials ..... JOHN T. FAIG
2. Hydraulics ..... GEO. E. RUSSELL
3. Heat Thermodynamics and Thermometry ..... S. A. MOSS
4. Photometry and Illumination ..... E. C. CRITTENDEN
5. Aeronautics ..... JOS. S. AMES
6. Mathematics and Mathematical Signs ..... E. V. HUNTINGTON
7. Electrotechnical Symbols and Abbreviations, including Radio ..... J. F. MEYER

By the time this is published many of the subcommittees will have elected permanent officers and will have started the standardization of the scientific and engineering symbols and abbreviations that come within their scope.

The Executive Committee of the Sectional Committee on Scientific and Engineering Symbols and Abbreviations is the following:

H. N. DAVIS
A. E. KENNELLY
S. A. MOSS
C. M. SPOFFORD
J. F. MEYER, *Chairman*
PRESTON S. MILLAR, *Secretary*
S. McK. GRAY, *Assistant Secretary*

The accompanying organization chart will make clear the relationship which the Society for the Promotion of Engineering Education and other engineering societies of the country bear to the Sectional Committee on Scientific and Engineering Symbols and Abbreviations.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The American Society of Mechanical Engineers
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A. E. S. C. Sectional Committee on Scientific and Engineering Symbols and Abbreviations
Executive Committee, A. E. S. C. Sectional Committee on Scientific and Engineering Symbols and Abbreviations
J. J. Meyer, Chairman
S. A. Moss, Vice Chairman
Preston S. Millar, Secretary
S. McK. Gray, Ass't Secretary
H. N. Davis, A. E. Kennelly, C. M. Spofford
1. Sub-committee on Mechanics, Structural Engineering and Testing Materials
Temporary Chairman John T. Faig
2. Sub-committee on Hydraulics
Temporary Chairman Geo. E. Russell
3. Sub-committee on Heat, Thermodynamics, and Thermometry
Temporary Chairman S. A. Moss
4. Sub-committee on Photometry and Illumination
Temporary Chairman E. C. Crittenden
5. Sub-committee on Aeronautics
Temporary Chairman Jos. S. Ames
6. Sub-committee on Mathematics and Mathematical Signs
Temporary Chairman E. V. Huntington
7. Sub-committee on Electro-technical Symbols and Abbreviations, including Radio
Temporary Chairman J. F. Meyer

COLLEGE NOTES.

University of Louisville. During the winter quarter of the Speed Scientific School (the engineering school) the following speakers have appeared and addressed the students at the general engineering assemblies:

F. F. Gilmore, Director, Louisville Safety Council, "Accident Prevention."

Kendall Weiseger, Personnel Director, A. T. & T. Co., "Personnel Work in Engineering."

H. V. Coes, vice-president and general manager, Belden Co., "The Engineer as an Executive."

W. K. Bradbury, Director, Public Relations Department, Niagara Falls Power Co. "Power Development and Scenic Preservation at Niagara."

Robert L. Schmitt, Secretary. Louisville Safety Council, begins a course of six lectures on "Safety in Industry."

G. E. Whitwell, American Gas Association, "The Gas Industry."

University of Wisconsin. The resignation of Dean Louis E. Reber, of the University Extension division of the University of Wisconsin, at the age of 68 brings to a close an active career which, in itself, represents one of the significant chapters of educational history in the United States. Coming to Wisconsin in 1907 from Pennsylvania State college in which he was dean of the School of Engineering, Dean Reber assumed charge of an extension division which consisted of three men working in two rooms of Bascom hall.

The first university extension instruction in the United States consisted of lectures by professors who left their class rooms for a day or so and of a species of "lyceum." The first organized extension instruction appeared in the United States in 1892 at the University of Wisconsin and the University of Chicago. It was not until 1906, however, that extension instruction was done very systematically. In that year

Wisconsin reorganized its extension division and elected Dean Reber to the position of "director." In 1907 the legislature accepted extension as a feature of the state educational program.

Chester D. Snell has been appointed acting dean of the University Extension division to succeed Dean Louis E. Reber. Mr. Snell is director of the University of North Carolina Extension division.

Mr. Snell received the B.A. and M.A. degrees from Columbia university. He has been director of the North Carolina Extension division for six years. He will assume his duties at Wisconsin at the beginning of the 1926–27 academic year.

BOOK REVIEW.

Balloon and Airship Gases. Part I by CHAS. DE FOREST CHANDLER, Lieut. Col., U. S. A. (Retired); Part II by WALTER S. DIEHL, Lieut., U. S. N. Ronald Press Co. x + 226 pages $5\frac{3}{4} \times 8\frac{1}{4}$. Illustrated.

This book is one of a series by the Ronald Press which deal with the various aspects of aëronautics. Part I deals broadly, as well as in some detail, with the methods, economics, difficulties, and dangers of hydrogen and helium production, compression, storage and handling. Part II is only about one fourth as long as Part I. It gives data and formulas for the solution of aëronautical problems in the thermodynamics and mechanics of gases. An appendix contains a reference bibliography and tables of gas contents.

A. B. C.